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BIM Application Process for Facility Condition Assessment Documentation Work

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***Abstract:** Overseas countries' government and facility management industries make efforts to ensure precise and fluent data from building information modeling (BIM). In facility management, a large amount of data and information are necessary to continue the process activities. Facility condition assessment, which is performed to make budget plan for the maintenance and operation requires the related facilities' documentation and information. However, it depends on the owner and the user of the facility to provide accurate and complete information to consultant. The problems as follows: (1) owner and user should provide documents and information, and (2) the consultant cannot verify the provided information. To solve these problems, we suggest a methodology to produce the information for FCA through BIM. First, all of the essential documentation and assessment elements are listed. Next, the documents and elements are separated out, whether they are able to be extracted from BIM or not. Then, the list indicates only the data that is linked with BIM. The suggestion is expected to provide the required information through the connection to BIM with accuracy and completeness and to present another BIM application use for facility management.*

***Keywords:** Facility Management, Facility Condition Assessment, Building Information Modeling, IFC, IFC Property Set*

I. INTRODUCTION

According to the BIM Guide for Facility Management, facility data is created in the design and construction process and the data allows one to take advantage of the following: Accurate as-built information reduces the cost and time required for renovation, increases customer satisfaction, and optimizes the operation and maintenance system of one building to reduce energy consumption [5]. In a few countries, building information modeling (BIM) has been used for facility management to earn the mentioned effects [1]. To perform facility management, the facility requirements must be clearly defined and the budget decision-making process is critical to planning operation and maintenance costs and priorities. In this regard, facility condition assessment (FCA) is considered a fundamental tool for establishing facilities requirements [2].

To increase the consultant's understanding of the subject facility and the inspection of its physical deficiencies, the owner and the user must provide a document for the facility condition assessment. Accuracy and completeness of the information depend on the source because the consultant has no need to verify its mistakes or insufficiencies. In other words, there are two main problems in the FCA process: (1) owner and user should provide documents and information, and (2) the consultant cannot verify the provided information.

To solve these problems, we suggest a methodology to produce the information for FCA through BIM. First, all of the essential documentation and assessment elements are listed. Next, the documents and elements are separated according to whether they are able to be extracted from BIM or not. Then, the list is indicates only the data that is connected to BIM.

II. LITERATURE REVIEW

A. Facility Management

According to BS 15221-5:2011, facility management is the "integration of processes within an organization to maintain and develop the agreed services which support and improve the effectiveness of primary activities." Its process consists of the inputs, the activities, and that outputs that are needed for the satisfaction of the demands.

> "Process activities are actions performed by specific actors, usually persons, in the planned order to reach the target outcome. ... The process planner needs to have all required data, information and resources, as well as the knowledge and experience of the outcome" (BS 15221-5:2011, 12).

In this context, United Kingdom government has a plan to utilize BIM systemically in construction industry; its final objective is to develop BIM for life-cycle management and it focuses on using BIM in facility management by exchanging BIM data with a data system. The government expects that the level of development of

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BIM is LOD 500 to achieve the goal and then the model allows the complete data exchange by containing every required data for facility management [4].

B. Facility Condition Assessment

"A facility condition assessment (FCA) is an information system customized for the input, storage, manipulation, and reporting of facility related information" [10].

As mentioned in the introduction, FCA is a key tool for budget decision-making; therefore, HHS has a specific policy to conduct FCA. The HHS Facilities Program Manual states the followings:

A. HHS land-holding will conduct visual facility condition assessment of their constructed (buildings and structures) at a minimum of once every five years to identify associated deficiencies.

B. The purpose of a desk-top [1] assessment is to update the cost-basis of visual assessment, to add any deficiencies that have emerged since the last visual assessment, and to delete any deficiencies that have been mitigated since the last visual assessment.

C. Condition assessment data will be reported in compliance with HHS ARIS (Automated Real Property Information System) data and data transport standards.

D. Available capital will be invested in the maintenance, repair, renovation and construction of facilities consistent with condition assessment metrics, sound business practices, and HHS/OPDIV priorities (HHS, 2-1).

The scope of the assessment is to identify and evaluate physical deficiencies. In addition, assessments identify existing warranties, provide opinions of costs for repair needs, and review a checklist [2] for the elements during the assessment. The quality of FCA depends on the qualifications of the assessment team; therefore, the minimum qualifications of the assessor and the reviewer are stated in the manual as well.

Ⅲ. THE LINKAGE BETWEEN BIM AND ASSESSMENT ELEMENTS

A. General Documentation

Before identifying physical deficiencies and repair needs, the assessor should generate a pre-survey questionnaire to gather the details about the records and maintenance history. These details are used to increase the assessor's understanding. The list of information is specified in the manual and ASTM E2018-08. There are nine common items from the two lists, and five items from the ASTM standard guide describe in detail the common items because the ASTM deals with properties.

The items can be categorized in three ways: (1) items can be extracted from BIM through the property set classified by the object, (2) items can be extracted after developing additional processes, and (3) items cannot be extracted from BIM data. Throughout these categories, six items can be managed by BIM, six items need additional development to be managed, and four items remain things that the person in charge has to provide. The items are shown in table 1.

Table 1. A categorization of the general documentation

Items are manageable through BIM or not	HHS Manual	ASTM Standard
Manageable	1. Safety inspection records 2. Warranty information 3. Records indicating the ages of systems 4. Historical costs for repairs, improvements, replacements, etc. 5. Previous assessment and studies and the status of any previously identified repair needs	6. Previously prepared property condition reports or studies pertaining to any aspect of the subject property's physical condition
Manageable with additional process	1. Certificate of occupancy 2. Outstanding code violations	3. The ADA survey and status of any improvements implemented to effect physical compliance 4. Records indicating building occupancy percentage 5. Building rent roll as it relates to tenant count or leasable area 6. Leasing literature, listing for sale, marketing/ Promotional literature
Handwork	1. Description of future work and contracts/ proposals for executed and planned capital projects	2. Appraisal, either current or previously prepared 3. Pending proposals or executed contracts for material repairs or improvements, etc. 4. Descriptions of future improvements planned

The property set schema should be defined by EXPRESS language to adopt the IFC schema directly. In this property set schema, the detailed property data is related to the IfcPropertySet entity. In this regard, if the detailed property data is already referenced in an object library, the property set data for FCA can be inputted into the subject automatically and systemically. Since the property set is defined by the IFC schema, the detailed property data can be exported to an IFC file using the BIM-based authoring program's IFC translator. Therefore, six items are manageable with additional process that need to be defined in the IFC schema. In the schema, the items, such as certificate of occupancy and outstanding code violations, are defined to be included in the description attribute of the IfcSpace entity. Four items

[1] A "desktop" assessment will be conducted every year in the off-years of the visual assessment cycle.
[2] See Appendix B in the *HHS Facilities Program Manual*.

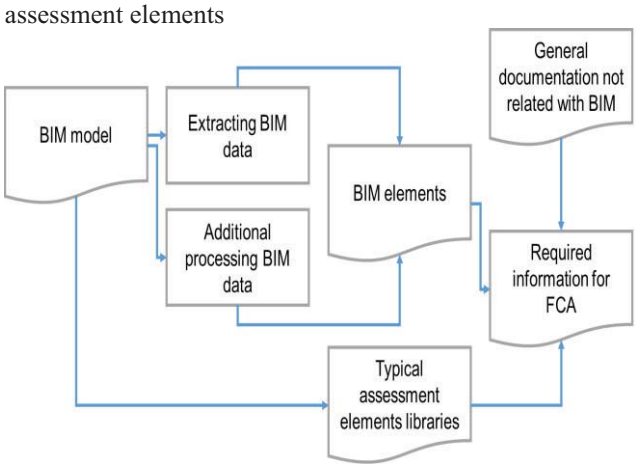
are not necessary to link to BIM, since the information is not related to the present facilities' condition. For instance, the "description of future work and contracts/proposals for executed and planned capital projects" is not an essential element of BIM but the documentation of the budget plan. Thus, the items remain the work of the owner and the user.

B. Typical Assessment Elements

Typical assessment elements include visual observations for facility condition assessment. An assessor should provide his own formatted checklist that includes the elements, and he/she should record the general physical condition of the constructed assets and should identify the physical deficiencies observed or reported. The list is contained in Appendix B of the HHS Facility Program Manual and figure X1.1 of ASTM E2018-08.

There are twelve class levels: site features, structural systems, roof systems, building exterior elements, interior finishes and appliances, fire and life safety, mechanical systems, cooling and ventilation systems, electrical systems, plumbing systems, vertical and horizontal transportation, and accessibility. For example, the site features class, consists of type/material, age, approximate quantity (area/length), condition, and previous repairs. These subcategories can be managed by a library using the IFC schema in the same way as the six items mentioned earlier; thus, every typical assessment element is manageable through BIM-based libraries for FCA documentation work. The process of the linkage between BIM and assessment elements is described in figure 1.

Figure 1 A process of the linkage between BIM and assessment elements



IV. CONCLUSION

According to the SmartMarket Report [1], major countries, nine of the world's top construction markets, the discussion of BIM-based facility management is activated. While, the decision-making process is critical in the budget plan for operation and maintenance of the facility management system. To make a budget plan, it needs to determine the priority of repairs according to the facilities condition assessment by identifying the physical deficiencies. It is an advanced work to provide required documentation and information for the walk-through survey and the visual inspection. The paperwork is performed by the owner and the user of their facility; thus, the quality of the information depends on them. Therefore, a suggestion in this research presents a methodology of BIM-based framework to manage the information automatically and systemically. The process is possible by linking the information with the libraries of the IFC schema.

This methodology contributes to the object-oriented information management and the activation of information-based data utilization in facility management industries. The suggestion is expected to promote implementation of BIM for facility management ultimately. Nevertheless, BIM should be designed and modeled as Level of Detail (LOD) 500 to extract all of the required information from BIM. Additionally, it has not been developed yet to utilize BIM for facility condition assessment in the system or the infrastructure. It is necessary to verify the process and to build an environment for BIM-based FCA in the future study.

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